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PLASMA DIAGNOSTICS AND THRUST PERFORMANCES OF THE HALO THRUSTER WITH PERMANENT MAGNETS

Abstract

Low power Electric Propulsion (EP) systems have become of particular interest in conjunction with the advance of small and micro satellite technologies. Among the different EP concepts, attention is especially given to innovative Hall-type configurations which combine the main advantages of the ExB acceleration mechanisms along with promising performance figures. These novel concepts make use of discharge channel geometries with higher volume-to-surface ratio and singular magnetic field configurations to overcome the wall plasma losses, erosion and heating issues, which are the main cause of annular HETs loss of performances. In 2010, the Halo thruster project was developed at the Surrey Space Centre (SSC), University of Surrey, in collaboration with Airbus Defence and Space, Surrey Satellite Technology Ltd (SSTL) and Imperial College London. An electromagnet (EM) laboratory model previously demonstrated efficiencies at 100 − 500W comparable to the state-of-art annular HETs of similar sizes, Cylindrical Hall Thrusters (CHTs) and Cusped Field Thrusters (CFTs). More recent studies are focused on a novel PM Halo version, which features a cylindrical discharge channel and takes advantage of the strong magnetic field provided at small scale by SmCo permanent magnets (PMs), to create a cusped magnetic field with regions of magnetic field cancellation. These zones, where the B-field cancels exactly to zero, are separated in the discharge channel by a strong radial magnetic field and are bounded by cusp structures which weakly confine electrons, leading to the hypothesis that local increases in plasma density and improved thrust efficiency can be obtained. In the past year, parallel efforts were made to further improve PM Halo thruster design and upgrade SSC EP facilities to include new architectures and diagnostic tools for accurate thruster characterisation and plume investigation. Two different PM Halo thruster concepts are under investigation: a conventional design with an externally located hollow cathode neutralizer (HCN) and a novel configuration with the HCN mounted along the thruster centreline. This paper presents an overview of activities performed on the Halo thruster at the upgraded SSC EP facilities. These include thrust magnitude measurements of the two PM Halo thruster models, ion current fluxes and multiply charged ion fractions collected by mapping the plasma plume at 180 by Faraday and ExB probes, waveform oscillations data and optical emission spectroscopy (OES). Results are compared at different power level, changes in propellant mass flow rate and electrical configurations.